GSI HEALTH, LLC

Response to Request for Information (RFI)

Arkansas Health Information Exchange (HIE)

May 7, 2010

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Section 1. Cover Letter

May 7, 2010

Ms Alison Nicholas
Arkansas Coordinator for Health Information Technology
1401 West Capital, Suite 300
Little Rock, AK 72201

RE: Request for Information for Arkansas Health Information Exchange

Dear Ms. Nicholas:

GSI Health, LLC is pleased to submit a response to the Request for Information (RFI) released by the Arkansas State Health Alliance for Records Exchange (SHARE) regarding creation and implementation of an interoperable health information exchange (HIE) structure for the State of Arkansas. Our offering, the GSI HIE, consists of an Enterprise Service Bus (ESB) HIE and associated web services, is defined further in this response. Alongside the technical details is a description of our expertise as: technical leaders of interoperable HIE architecture at the State HIE level, Program Managers for the Healthcare Information Technology Standards Panel (HITSP), and the developers and operators of a Regional Health Information Organization (RHIO) HIE in Upstate New York.

After reviewing the architecture and requirements of the Arkansas HIE RFI, we believe our solution provides the service-oriented architecture integral to connecting disparate endpoints in a heterogeneous environment while providing a technology-agnostic solution rooted in the prevailing national standards of the Nationwide Health Information Network (NHIN), HITSP, Integrating the Healthcare Enterprise (IHE), and Health Level 7 (HL7). Our service offering includes GSI HIE Core Services such as NHIN-compliant Privacy and Security, Data and Terminology Normalization, Master Patient Index , and an advanced Administrative Portal. Additionally, our functional services includes Clinical Summary Exchange (CSE), Medication Management and e-Prescribing, Lab Order/Results services as well as value-added services for Public Health Tracking and Surveillance, Quality Reporting, Personal Health Record (PHR) integration and Clinical Decision Support.

I am confident that our proposed solution delivers upon the SHARE design and is augmented by our strong credentials in HIE development, healthcare technology standards, and our alignment with the SHARE architecture that can leave no provider behind.

Please contact me directly with any questions you may have about GSI Health or our response. We would welcome an opportunity to respond to a formal Request for Proposal (RFP) or provide a presentation of our proposed solution as part of your qualifying process.

Thank you for your time and consideration in reviewing our response. We look forward to hearing from you soon.

Sincerely,

LeRoy E. Jones
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Section 2. Executive Summary

In response to the RFI for the Arkansas HIE, GSI Health has evaluated the desired architectural components, functional requirements, and the required web services and transaction patterns. The GSI HIE proposed herein provides a service-oriented architecture consisting of a series of web services deployed through an ESB that brokers all transactions. Our architecture is founded in an open source solution that consists of transaction patterns defined by the prevailing national health information technology (HIT) standards including NHIN, HITSP, IHE and HL7 while augmenting these transactions through hardened interfaces for network consistency and efficiency including data and terminology normalization. Our privacy and security layer provides flexible consent policies along with structured access, authorization, authentication, and audit policies that are administered through standard HIE credentials and an advanced Administrative Portal.

While the GSI HIE architecture provides a means for connecting disparate endpoints including hospitals, electronic health records (EHRs) and data sources, our HIE provides the flexibility to conduct transactions in a heterogeneous environment that can integrate existing HIEs, legacy systems and HIEs current in development, direct connections to EHRs and access through a secure Web Viewer application. The foundation of the GSI HIE consists of a series of Core Services necessary to conduct transactions to specified endpoints for clinical summary exchange, medication history requests and data endpoints such as commercial laboratories and electronic prescribing services, as well as value-added services to integrate PHRs, Public Health Surveillance, tracking and response, Quality Reporting to communities, Health Information Organizations (HIOs) and payers, as well as Desktop Alerting and Disease Management.

Our technical infrastructure provides HIE fail-safes including disaster recovery, service monitoring, backup and load balancing vital to delivering and coordinating critical health information for patients, providers and State officials. This proposal contains an analysis of the necessary infrastructure, development, architectural and vendor integration efforts to deploy a pilot instantiation of the GSI HIE within Arkansas as requested. While our solution can efficiently scale horizontally and vertically, our cost structure recognizes that certain variables such as the volume of providers with advanced EHRs are easier to integrate from timing and cost perspectives than those more basic solutions.

Our solution deployment approach is based on experience with the leading EHR and Hospital Information System (HIS) providers, and their currently deployed platforms and the ability to integrate with the GSI HIE and the Arkansas HIE architecture specifications defined in the RFI. Our timeline consists of a phased rollout that begins with Core Services released in the first three months and maintenance beginning thereafter. Phase 2 then begins where a prioritized deployment of functional services that will include lab order/results, public health surveillance, and clinical summary exchange which will be completed between months 4 through 9. Phase 3 begins thereafter where we will deploy the medication history and electronic prescribing service, Quality Reporting and Disease Management Support in months 10 through 15. Our solution will be able to rapidly connect existing HIEs and HIOs presently capable of connecting via standards based transactions that are aligned with the Arkansas HIE and GSI HIE architecture. Platforms needing to build to the desired interface will follow subsequently due to vendor software development cycles. Our EHR and HIS rollout will occur across the entire engagement

beginning in Phase 2 while our Web Viewer solution can be deployed concurrently in Phase 3, providing access for users without an EHR or hospital system.

Section 3. Vendor Information

3.1 Name and Category of Respondent

GSI Health is responding to this RFI as a systems integrator. This is our forte as a company as we have developed expertise at integrating clinical systems to allow healthcare information to be shared appropriately. The data is shared through secure connectivity and with appropriate consent principles. GSI Health is an industry leader in the integration of healthcare data and is pleased to submit a response to this RFI in that capacity.

3.2 Name of Vendor Representative

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3.3 Collaborative Partners

GSI Health commonly works with a common team of collaborators to deliver a high quality solution to the State of Arkansas for an HIE solution. We have not contracted with these partners for this effort but rather would establish contractual relationships with all partners during the RFP process and upon contract award from the State, should we be chosen. Further, our core solution is primarily based on open-source technologies, and does not require bundling of third-party solutions or services to be deployed, and any such bundling that is deemed desirable will be accomplished through turnkey procurement. In this regard, we do anticipate procuring licenses for a medical-terminology solution and for business-intelligence software, likely Apelon and Business Objects respectively.

A brief discussion on our partnering approach is warranted here. Our philosophy about healthcare information networks has a few tenets. The first is that the network should be open for all to connect to. This means we do not seek to advance a single solution for end-user functionality, but rather wish to provide a platform for a variety of solutions to be offered, enabling market forces to drive the best solutions to be used. A second tenet is that the network should not compete with the solutions and services offered through it. Many so-called platform vendors offer products that overlap with point solutions, like EHR-lite applications and the like. We believe this is a barrier to our first tenet being realized inasmuch as the perception of having an inside advantage leads to controversy and retards efforts to bring increasing value to network users through the provision of a variety of point solutions and mash-up solutions. A GSI Health network is very much like a marketplace in that sense, connecting users with solution providers.

A third tenet is that a restricted network has a responsibility to ensure safe use of the network by all participants. This means that the network administration should provide reasonable safeguards against rogue use of the network by any participant in a manner that threatens other participants. Therefore, GSI Health networks assist network operators in ensuring safe admittance of service providers and ongoing verification that network standards are continually adhered to. This means maintaining passive controls like logging, and active ones like synthetic transactions that our integrated solutions must be able to process in a production environment. Each service provider we bring to the table is made to understand these tenets, and will work to preserve them.

Possibly the most important tenet we have regarding information networks is that they should have inherent value through immediate provision of services and functionality. This is the driving principle behind assembling a team of solution providers to partner with us. We intend to integrate their respective solutions in a protocol-compliant way, so the network has value out of the box. We believe that along the way, other solution providers will be identified by the Arkansas users for integration, and those solutions will also be integrated. Therefore, we do not need to be exhaustive in our partner selection, but strategic to bring key solutions that can deliver extraordinary value alone, or in combination with other network-service offerings.

Section 4. Summary Description of Solution

Our proposed solution is classified in three categories of core services, clinical functions and administrative components. For the State of Arkansas, we propose an incremental statewide implementation approach spanning across above-mentioned categories. The implementation will start with the core services along with its extension points for clinical function service integration. The clinical function services will be rolled out incrementally; each followed by integration testing with providers and regional HIEs in the State of Arkansas. The following table describes different phases of the implementation plan along with activity breakdown. Please note that the proposed order of clinical function rollout is subject to change based on specific requirements for the State of Arkansas.

Phase	Task/Activity	Notes/Description
Phase - 1	GOAL – Build/deploy/certify Core services required for Arkansas (AR) statewide HIE platform	
1.a	AR statewide HIE platform IT Infrastructure Analysis/Setup	Initial analysis IT infrastructure projections based on state requirements and building the appropriate environments for implementation.
1.b	AR HIE Infrastructure Support Services rollout	Includes statewide ESB, Universal Description, Discovery and Integration (UDDI), Security and Privacy, logging, monitoring, security module.

Phase	Task/Activity	Notes/Description
1.c	Internal Quality assurance Certification for infrastructure support services	GSI Health's Quality Assurance (QA) team will be responsible for this testing activity.
1.d	Rollout of Registry/Repository Services with IHE profile support	This is the first set of CORE services required to facilitate clinical information exchange through statewide HIE bus. (Includes Patient/Provider/ Consent/Organization registry services and Document Repository services.)
1.e	Deployment of HIE platform Administration application	This web-based application will allow system administration and configuration to bring the participating entities on the statewide HIE platform.
1.f	Internal Quality assurance Certification for registry/Repository Services	GSI Health's QA team will be responsible for the internal system certification for HIE core services platform.
1.g	Integration testing with participating EHR vendors/Regional HIEs	After the internal QA certification, we will integrate the participating entities (existing HIOs in AR, practices with EHR, partner EHR vendors) to certify the core service platform for successful communication gateway for statewide network.
Phase -2	GOAL – Implement/Certify first round of clinical service functions followed by Arkansas HIE's participating entities integration	(Includes Clinical Data Exchange, Lab order/results Delivery, Quality Reporting and Public Health Network Reporting)
2.a	Clinical data (payload) validation module rollout with Terminology Services conforming to HITSP standards	The data validation along with the terminology management service will be deployed for uniform transport of CCD – providing HITSP C83/C80 support. This will serve as foundational service for clinical data exchange uniformity across HIE participating interfaces.
2.b	Clinical Information Exchange Service roll-out with HIE participants integration	Using the registry/repository/terminology services, GSI Health will rollout 'clinical data exchange' as a first functional service directly utilized by HIE participants.
2.c	Lab Orders/Results delivery Service roll-out with lab service provider *(Labcorp)* and service consuming providers on AR- HIE platform	Roll-out of lab service will be followed by integration with LabCorp & physicians on the HIE platform.
2.d	Quality Reporting Service roll-out & vendor integration with practices with EHR and existing regional HIEs	Quality reporting will utilize the document repository and publish/subscribe core services for integration with participating practices.

Phase	Task/Activity	Notes/Description
2.e	Public health network Service roll-out & clinical data provider (RHIOs) integration certification	Public health network service will aggregate the HL7 feeds from hospital systems and will be integrated with regulatory or reporting entities as required by state of AR.
2.f	Arkansas statewide HIE platform IT Infrastructure Review / Scaling	After Phase 2 clinical function services rollout, GSI Health will evaluate the existing load on the AR statewide service bus IT infrastructure and scale if necessary.
Phase -3	GOAL – Implement/Certify next round of clinical service functions	(Includes clinical function services for ePrescribing, Payer unification and web Viewer)
3.a	ePrescribing Service Rollout	The integration certification for Medication Management service rollout will be performed with Medication vendor per state's requirements.
3.b	Payer Unification rollout	The service rollout will be followed by integration with payers focus group (recommended by state) and EHR/HIS vendors for the participating.
3.c	Web Viewer for practices with no EHR	This web application for providers with NO EHR will be delivered and deployed in production environment after the state required clinical service functionalities are certified and become operational on statewide network.
3.d	AR statewide HIE platform IT Infrastructure Review / Scaling	After this phase of clinical function services rollout, GSI Health will evaluate the existing load on the AR statewide service bus IT infrastructure and scale based on the transaction volume, physicians/organization service subscriptions.
Phase -4	GOAL – Maintenance and Scaling of HIE platform for more participants	
	Increase user base for the HIE platform by adding more physicians, regional HIEs and practices with NO EHR to the network	This phase primarily will increase footprint of the statewide HIE network in Arkansas by integrating with additional EHR/HIS vendors operating in the State. This will also include the maintenance and support enhancements to improve operational efficiency based on existing participant experiences.

Section 5. List of Current Installed Locations

GSI Health designed and operates an HIE for the primary technical vendor for the Taconic Health Information Network and Community (THINC) RHIO in New York. In this capacity, GSI Health is deploying a full-service solution that provides clinical messaging, document exchange, quality reporting, public health surveillance and integration of a heterogeneous environment of hospitals and EHRs. In addition, GSI Health designed and developed an Open Source software solution that connects hospitals and EHRs with HIEs to deliver clinical data that is currently deployed as part of the Universal Public Health Node (UPHN) Open Source for the New York State Department of Health (NYSDOH). This solution is installed in three major New York State RHIOs and connects hospital and EHR systems in order to aggregate and provide data to NYSDOH to deliver public health surveillance and investigation data as well as critical hospital assets for emergency preparedness and response planning.

Additionally, GSI Health has also provided technical architectural leadership and technical strategic and operational planning guidance to the NYSDOH for the deployment of the Statewide Health Information Network for New York (SHIN-NY), a network of networks connecting clinicians, hospitals, data providers, RHIOs, EHRs, and State Agencies. In this capacity, GSI Health developed a standards-based technical solution in a vendor-agnostic paradigm to leverage ESB platforms, secure messaging protocols, and disparate database platforms to deliver multiple services centered around clinical use cases designed to reduce cost, improve access to care-related data, and facilitate health information exchange across multiple endpoints.

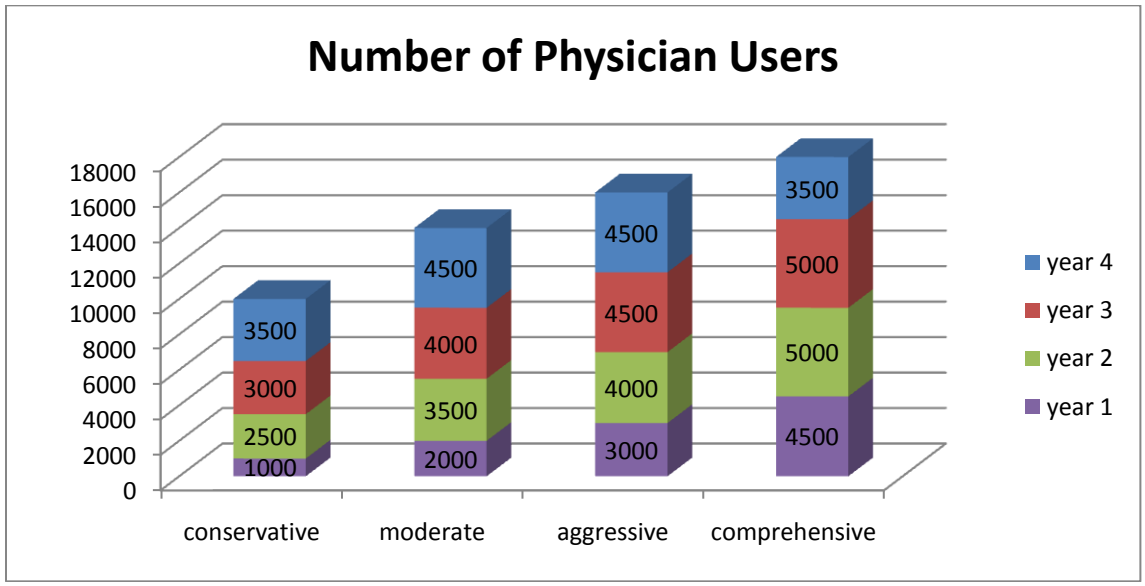
Section 6. Estimate of Implementation Timeline

The deployment of the interoperability capabilities to providers is a nontrivial undertaking. After the appropriate vendor product has integrated the capabilities for information exchange, the new version needs to be deployed into the production environment. Even though many vendors host edge applications for providers, they often maintain distinct production configurations for their customers, meaning that potentially every provider organization will need to have individualized service at some level to upgrade. A further complication is introduced when providers have custom enhancements to their installed version, which means a migration of the new functionality to an older baseline of the vendor product, or a migration of the provider's non-standard functionality into the newer version. Many providers will be acquiring the entire edge application anew, and will need to complete the sale and installation cycle with a capable vendor. In our experience, the upgrade of a system can take from 350 hours to 850 hours of effort across all parties when the provider already has the vendor's system installed, and may last from 12 to 30 business days. If the system must be sold and installed, the level of effort escalates to approximately 2500 hours of effort across all parties during a potential 400 day evolution through sales and deployment.

The work involves the vendor staff, provider staff, and the staff of the interoperability-backbone operator. The costs involved in the rollout to providers has to be borne by the market transactions between the vendor and provider to make it tenable, but the operator has real costs, particularly during the early generations of the statewide network (more kinks and educational issues to overcome). The operator will need to plan to allocate time and resources to supporting rollout

generally. Our initial estimate for this support during the four year period of performance is 4 hours on average per installation, but this number will be refined during the RFP process. The primary point here is that installation support will utilize contract dollars for this initiative, but the contract should not expect to pay for all associated costs.

Deployment to providers is really deploying to the provider organizations. Given the skew of providers into small practices (historically reported by the American Medical Association (AMA) as around 60% in 1 – 4 doctor practices), the number of organizations is the atomic unit for determining the effort involved in rollout to providers. Again, based on historic reporting by the AMA, we can expect roughly 450 deployments per 1000 doctors. The question then becomes how aggressively can the rollout be and still maintain logistical control of the process, and maintain a sustainable budget. Some states have set initial targets, such as 1000 clinicians in the first year, and incrementally scale from there. Our approach here would be to meet the objectives of the State, and therefore we describe several options for deployment to providers here. The following chart summarizes the year-over-year deployment to providers, based on different objectives for coverage over the four years:



It is important to realize that practical reasons typically prevent 100% compliance with most efforts. Preliminarily, we would suggest the moderate course that gets most providers with some of the interoperable functionality, depending on the integration schedule of the involved vendors. This requires about 75 to 170 organizational upgrades or installations per month on average across the pool of compatible vendors. Because many clinicians will likely adopt EHRs sooner for the sake of the American Recovery and Reinvestment Act (ARRA) incentives, many of these deployments will be upgrades, which make the task more tenable in a compressed 4 year timeline.

Section 7. Description of Financial Business Models Supported

The proposed architecture enables support for financial business models based on subscription fees for connected users, transaction fees for specific clinical services, flat fees for services or service packages, and pricing for deployment based on connected edge system (EHR vs. EHR-Lite vs. Portal Solutions vs. Hospital Information Systems). The business model can be enhanced by providing selected services through a centralized solution at reduced costs to a large community of connected users that would otherwise be required to solicit connections independently at higher costs, or not implement services due to costly development, or cost-prohibitive pricing.

On an ongoing basis, the required support, maintenance, and upgrades for capacity, improvements to infrastructure and performance, additional services, and expanded endpoint connections, will require a significant funding. These costs can be subsidized by ongoing connection fees and decreased on a per-user basis by adding additional users to distribute the total cost of our highly scalable solution. Additional subsidies can be added by introducing additional sources that seek de-identified clinical data for clinical trials, testing, pilot implementations, as well as research programs.

Deployment costs can be addressed through several options including enabling edge systems such as HISs, EHRs, and EHR-Lites that are part of an offeror's solution to sell their product to endpoints and connect them to the Arkansas HIE which can diminish the cost to the HIE and the State for deployment. Furthermore, the GSI Health architectural philosophy is rooted in standards-based transactions from HITSP, IHE, NHIN, and HL7 and is technology-agnostic, therefore, potentially decreasing the cost to integrate many of the leading EHR and HIS vendors who can facilitate these transactions with minimal or no additional development and cost. Our architectural solutions are designed to enhance connectivity and ease integration burdens by fostering connections through existing solutions and the leading HIT solutions.

Section 8. Estimated Cost of Solution Components

The pricing model provided here is based on the model of deployment described in the previous section regarding provider rollout. This includes recognizing that the units of deployment are really around vendors and provider organizations, not physicians. Further, integrations centered on vendor capabilities are reusable at the provider organization level, making deployment much less expensive than they could be with individual deployments at each logical endpoint in the network. The term "vendor" here really refers to the entity that controls the technology that interfaces with the protocol bus, so an HIO may be a "vendor" in this sense.

The pricing ranges given are based on prior GSI Health projects, and will undergo more detailed treatment when the exact requirements of an Arkansas RFP are known. However, it does provide a model for pricing by identifying onetime costs for the Arkansas Protocol Bus, and those that are variable by vendor integration, and also those that are variable by deployment to provider organizations. The following table shows the pricing ranges for each item discussed for a prototype configuration.. Prototype assumptions may be further defined in the RFP. The last item

of note is that the high-end costs of the edge deployments assume the contract paying for costs that are normally part of provider pricing. We believe these are not necessary in this context, but included them in case Arkansas has a different model. This accounts for the significant differences between low-end and high-end costs. The following table illustrates the pricing model for the prototype scenario.

Prototype Pricing

	AR ESB	HS-HIO	R-HIO	PG-HIO	Hospital	practice 1	practice 2	practice 3	Lower-End Cost	Higher-End Cost	Low Total	High Total
Baseline HIO infrastructure (fixed cost - pay once)	x	x	x	x	x	x	x	x	$ 400,000	$ 1,000,000	$ 400,000	$1,000,000
Levels of technical integration (variable cost - pay per vendor)												
functionality build	x				x	x	x	x	$ 150,000	$ 600,000	$ 750,000	$3,000,000
interfacing			x	x					$ 75,000	$ 300,000	$ 150,000	$ 600,000
configure		x							$ 25,000	$ 100,000	$ 25,000	$ 100,000
Levels of edge deployment (variable cost - pay per installation)												
upgrade	x		x	x					$ 1,000	$ 75,000	$ 3,000	$ 225,000
legacy accommodation		x							$ 2,000	$ 150,000	$ 2,000	$ 150,000
sale cycle & install					x	x	x	x	$ 2,000	$ 350,000	$ 8,000	$1,400,000
MO Protocol Bus Functionality (fixed cost - pay once)												
Medication History	x								$ 150,000	$ 350,000	$ 150,000	$ 350,000
Lab Orders/Results	x	x		x	x				$ 75,000	$ 200,000	$ 75,000	$ 200,000
Clinical Summaries		x	x	x	x				$ 25,000	$ 150,000	$ 25,000	$ 150,000
eRx		x		x	x				$ 75,000	$ 350,000	$ 75,000	$ 350,000
HL7 2.x				x	x	x	x	x	$ 25,000	$ 100,000	$ 25,000	$ 100,000
Terminology Support				x	x	x	x	x	$ 100,000	$ 300,000	$ 100,000	$ 300,000
											$1,788,000	$7,925,000

Hardware Pricing for Prototype

Prototype Solution	Quantity	Per Unit	Upfront
SAN	1	42,000.00	42,000.00
HP Servers	3	8,000.00	24,000.00
Network Switch	2	1,500.00	3,000.00
ESX Software	3	2,500.00	7,500.00
ESX Virtual Center	1	1,500.00	1,500.00
Array Network Load balancer	1	16,000.00	16,000.00
Sonicwall Router	1	2,600.00	2,600.00
Microsoft Datacenter licenses	3	2,800.00	8,400.00
MySql Server licenses	2	2,500.00	5,000.00
		Total	110,000.00

Yearly Hardware and Software Pricing

Yearly Software\Hardware Maintenance	Quantity	Per Unit	Year 1	Year 2	Year 3	Year 4
HP Server maintenance	3	300.00	900.00	900.00	900.00	900.00
ESX maintenance	1	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00
Load balancer maintenance	1	3,000.00	3,000.00	3,000.00	3,000.00	3,000.00
SAN maintenance	1	3,000.00	3,000.00	3,000.00	3,000.00	3,000.00

Upgrade Costs

Expanded Capacity Upgrade Costs	Quantity	Per Unit	Upfront	
CPU upgrade	3	$1,200.00	$3,600.00	This is one upgrade
Memory upgrade	27	$325.00	$8,775.00	
ESX Software	3	$2,500.00	$7,500.00	
Microsoft Datacenter licenses	3	$2,800.00	$8,400.00	
Addition to VMware support per year	3	$680.00	$2,040.00	
		Total	$30,315.00	

Site and SAN DR Upgrade Costs	Quantity	Per Unit	Upfront	
SAN	1	52,000.00	52,000.00	This is one upgrade
HP Servers	3	8,000.00	24,000.00	
Network Switch	2	2,500.00	5,000.00	
ESX Software	3	900.00	2,700.00	
ESX Virtual Center	1	4,500.00	4,500.00	
Array Network Load balancer	1	16,000.00	16,000.00	
Sonicwall Router	1	2,600.00	2,600.00	
Microsoft Datacenter licenses	3	2,800.00	8,400.00	
MySQL Server software	2	4,500.00	9,000.00	
		Total	124,200.00	

Section 9. General Solution Description

For a statewide HIE platform for Arkansas to support providers' ability to satisfy Meaningful Use criteria, GSI Health's proposed solution provides a robust clinical information exchange framework. This framework with its set of core services deployed centrally enables participating entities to exchange clinical data efficiently and effectively. This set of core services are then used as a foundation to accomplish clinical function contexts like Lab orders/results delivery, quality reporting, medication management etc. We, at GSI Health, understand that standards are an integral part of building the functional HIE platform to accomplish interoperability for the Meaningful Use criteria. Our architecture is compatible with the NHIN abstract model, and we are active in NHIN's current project 'NHIN Direct' responsible to expand the standards and service definitions that will allow organizations to deliver simple, direct, secure and scalable transport of health information. Our proposed solution uses the NHIN technologies and our active participation in the 'NHIN Direct Implementation Group' will provide an easy "on-ramp" adoption towards the emerging standards and NHIN Direct's recommendations.

Our proposed solution to build the architectural framework for Arkansas's statewide HIE platform is classified in three inter-related functional capabilities.

- **Core Services Infrastructure –** This is the service oriented technical foundation required to build and consume the core services necessary in facilitating robust clinical information exchange among different healthcare entities in the State of Arkansas. This involves the registry/repository services, identity resolution, patient/provider identity synchronization with master patient indexing, web-service UDDI discovery and unified interface for the consuming healthcare entities and security among others. A key supplement to the

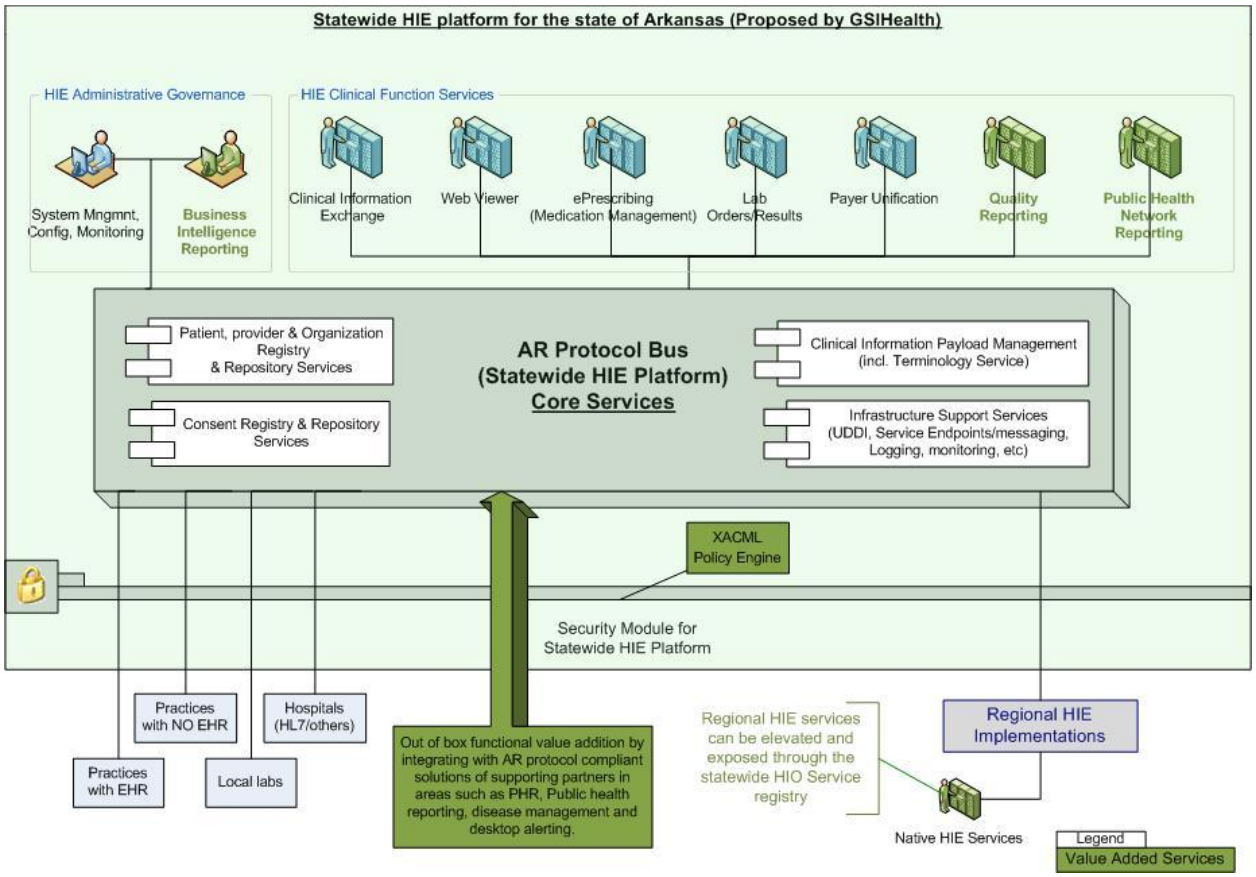
infrastructure is fulfilling privacy and security requirements for user authentication, role based access management and in-built consent mechanism for accessing patient information.

- **Clinical Functional Services –** Clinical stakeholders from the participating systems will be consuming the core foundational services built using the technical infrastructure. Combinational consumption of the core services will lead to the clinical use such as clinical information exchange, lab orders/results interoperability, connectivity for medication management, public health reporting, etc. Our offering also provides flexibility to a regional HIE platform to expose its custom service to statewide providers through the statewide HIE platform. This can be administered and managed through the state's infrastructure governance capability for service facilitation, integration and testing for subscribing consumers.

  For the providers without an EHR – our solution will provide a lightweight EHR functionality module in the form of Web Viewer for the clinical functional services consumption. The web viewer will be made available to all the HIE platform participants to access the normalized view of clinical data powered by Terminology services and appropriate consent mechanism.

- **Administrative Governance –** Once the technical infrastructure is built along with clinical services, a key capability of our proposed solution is an easy-to-use administrative toolset to manage the governance of participating stakeholders. The governance toolset provides web application for managing the participating providers and also service subscription/certification workflow support which can be customized based on the specific service needs. The second aspect of governance involves the reporting capabilities provided for HIE platform administration. This involves both canned and ad hoc reports for audit logs, monitoring metrics for transaction volume, periods of inactivity, etc. for each participating organization or at the aggregate level for the platform itself.

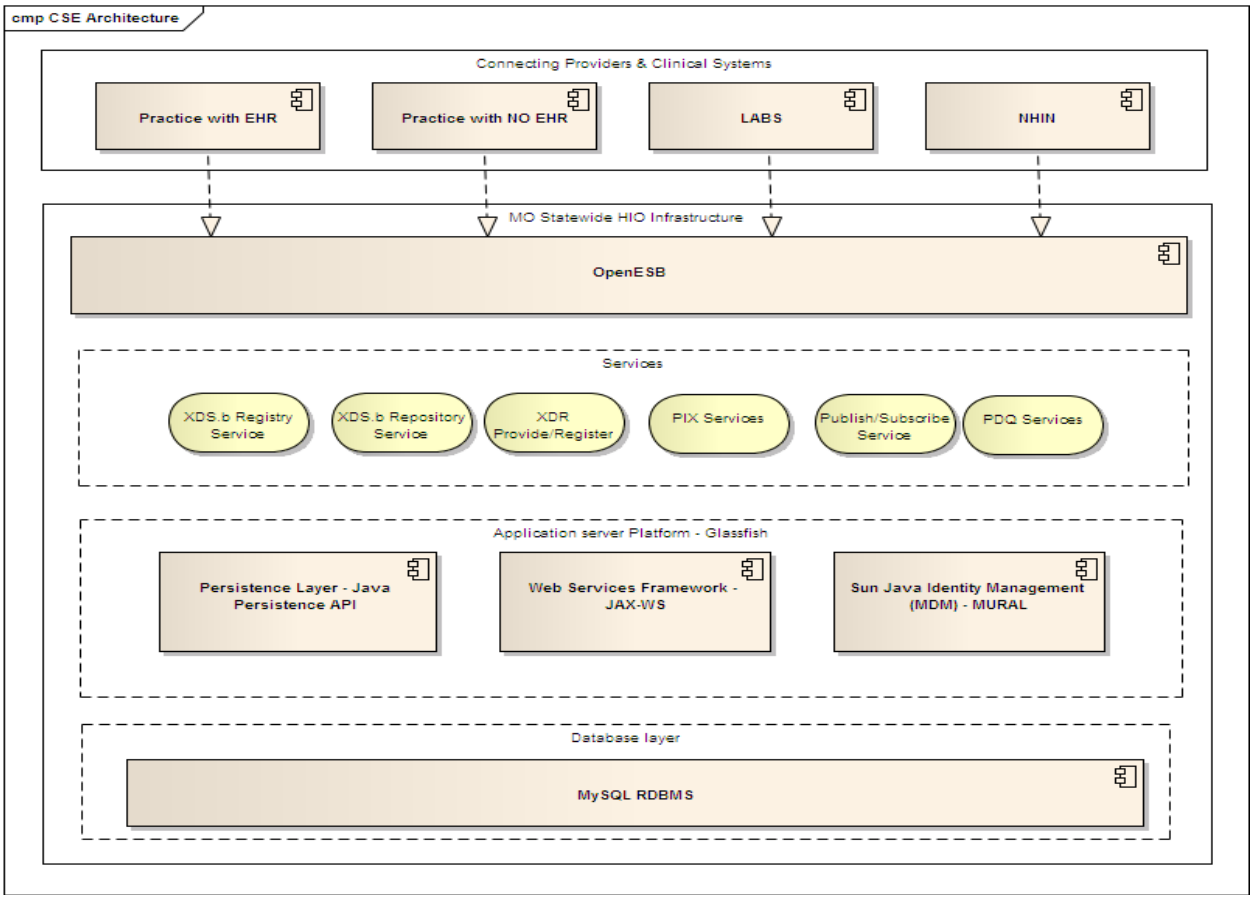
The diagram below depicts our proposed solution components at the functional level and describes its relation with the participants of the HIE platform. The green shaded box in the diagram describes the different components that will be built and deployed by GSI Health for project. The proposed HIE platform architecture will serve as a statewide gateway for the existing and new regional HIO implementations in the State of Arkansas as long as they conform with the NHIN abstract model's standards used by statewide infrastructure. In support of the "No Provider left behind," the healthcare entities (on left bottom) that are not affiliated with any HIO or hub will be managed as individual participants in the statewide platform with service subscriptions and end-points configured for each.



9.1 Technical Architecture and Approach

The proposed HIE platform infrastructure is an extensible framework developed with open source platform and adheres to service oriented architecture (SOA). All the components utilized by the interfacing systems have Simple Object Access Protocol (SOAP) (1.2) web service interfaces. The usage of web services over HTTPS as communication protocol makes the CSE services agnostic of the technologies used in the interfacing systems. Internally CSE uses the ESB design concept to provide the standard platform for the service integration. The loosely coupled ESB integration provides aspect oriented functionality for security, authentication, service orchestration and the guaranteed delivery of messages.

The diagram below describes the technical architecture for Arkansas's HIE platform's proposed solution.



As shown above – all the interfacing systems' web service requests are brokered through the ESB layer. The incoming request is subjected to the message optimization, reliable messaging and security enforcement using Web Services Interoperability Technology (WIST) in the ESB layer. The brokered web-service requests are catered by a set of core services as described in the IHE profile Cross-Enterprise Document Sharing (IHE XDS.b) and PIX/PDQ transactions for identity management for patients and providers. The HIE infrastructure facilitates exchange of clinical documents or document IDs among EHRs and HISs unable to receive unsolicited documents. In this capacity, the infrastructure supports both central and distributed repository models for clinical documents. In the central repository approach, infrastructure will stage documents in central repository in their original format, which can be retrieved by the EHR and HIS based on document IDs. When staged in the central repository, we parse certain CCD payloads (e.g. – C32), convert and present them in other standard document formats where applicable. Based on the specific use case for the document's usage, the terminology service using Apelon Distributed Terminology System (DTS), will be invoked to create the normalized version of the clinical document based on HITSP terminology standards. In the distributed repository model, end-systems will register the clinical document with the infrastructure but store it on the edge. This document can be then retrieved by consuming end-point or pushed to the consumer by subscribe-notify mechanism through HIE infrastructure. The infrastructure identifies and retrieves the appropriate document based on patient identification or patient demographic information. The document provided is registered in the central repository for the patient which is uniquely identified by the EUID (enterprise universal ID) in the integrated HIE platform. For the patient and provider identity synchronization, the infrastructure uses Mural – a

master data management suite which resolves the cross-system identity of the patient and providers based on the demographic information provided in the document or request message body. The design uses JAXB (Java -API for XML Binding) for the XML processing and JPA (Java Persistence API) for the object relational mapping for database layer implemented using MySQL.

The proposed HIE solution is developed/deployed/certified using the following technical components:

Item	Version	Purpose
Java/JRE	1.6	Development platform/language
Glassfish	2.1.1	Application server
OpenESB	2.2	Enterprise Application integration
Mural(/MDM)	1.0	Patient/provider identification Management solution.
OpenSSO	2.2	Single Sign On manager for web services
Metro	1.5	Web service security
Google Web Toolkit	2.1	Web UI technology for HIE administration application
Business Objects	BO XI R3.1	Business Intelligence Reporting for the HIE platform
Mirth	1.8	Clinical data validation/transformation
Apelon DTS	3.5	Clinical Terminology Service
NetBeans	6.7.1	Development IDE
MySQL	5.1	Database
SoapUI	3.0	Web services testing

9.2 Core HIE Service Requirements

All services described here implement security protocols to ensure bi-directional authentication and encryption. This means that Arkansas Protocol Bus services will not be available to unauthorized consumers. Arkansas Protocol Bus service implementation at the State level, for providers without regional affiliation, would be the same as the regional implementations. Regional Arkansas Protocol Bus instances can leverage services presented by the state level bus and vice versa.

Patient Registry - The Arkansas Protocol Bus (State Level) implements a standard IHE Patient Identity Cross Reference (PIX) interface mounted top of an implementation of the Mural Open Source Master Data Management System (also known as the SUN MDM). This MDM System has a strong market presence and is used as a patient registry in several European Countries. An IHE Patient Demographic Query (PDQ) interface is mounted on the same patient registry. The PIX and PDQ interfaces provide a standardized mechanism for uploading, updating and querying the patient registry, coupled to document registration and retrieval among others functions.

Provider Registry - The Arkansas Protocol Bus (State Level) implements a standard IHE Patient Identity Cross Reference for Users (UIX) interface mounted on top of an implementation of the Mural Open Source Master Data Management System (also known as the SUN MDM). In this case the MDM is strictly for maintaining system users, including providers, and not patients. Therefore, the acronym UIX (User Identity Cross reference) is used. An IHE Patient Demographic Query (UDQ) interface is mounted on the same user registry. The UIX and UDQ interfaces provide a standardized mechanism for uploading, updating and querying the user registry, coupled to the consent and External Data Representation (XDR) mechanism among others functions.

Organization Registry - The Arkansas Protocol Bus (State Level) User MDM registry has a self-contained series of Organization based tables related to the users. The organizations also have a series of tables maintained in the database backing the Administration Portal. All appropriate organization data and relations can be maintained in these two systems.

Consent Registry - The Arkansas Protocol Bus (State Level) implements an XDS.b Based Provide and Register Document transaction for XACML based documents. This allows HIS and EHR systems to supply patient consent documents in XACML format under a specific document type. Each consent document is linked to each patient by their Master Patient Identifier. These consent policy documents combined with a users authorization data (Admin Portal) and the Policy Engine data (See Policy Engine) allows for a determination of patient consent in specific cases of access to clinical information (e.g. document retrieval). The XACML based consent documents must be maintained consistent with any changes in State Policy. Transactions requiring NHIN based SAML assertion data help to ensure consent management is applied to the appropriate users in a trust model.

Web Services Registry (UDDI) - The Arkansas Protocol Bus uses a fully functional implementation of the UDDI version 3 specification for Web Services. If need be, a version 2 implementation is also available.

Web Services Endpoints and Messaging (Service Bus) - The Arkansas Protocol Bus implements store and forward, scatter and gather, and aggregation mechanisms as part of the normal messaging relay. Messages that pass through these points are logged in a database in detail. Service endpoints for relay are stored in the same database. Even simple synchronous XDS.b requests and responses are stored in this way (supplemental to normal IHE auditable events).

The Arkansas Protocol Bus implements an extremely functional Administration Portal. This portal allows for the configuration and certification of users, organizations, services, and service consumers. This includes security certificate exchange, security settings, role-based user authorization attributes, training and testing status.

Several different levels of administrators are allowed including bus administrators and several levels of organization administrators. Authorized users are tied into our "Provider Registry" for identification cross referencing across multiple organizations. Data on user document exchange endpoints and email addresses for Clinical Information Exchanges is also maintained in this system.

The administration portal is implemented within the application server and uses the Google Web Toolkit framework. The framework is AJAX based and extremely flexible, allowing for data entry and viewing.

Integration and Message Transformation - The capability of the Arkansas Protocol Bus to perform Message Transformation is described throughout this section of the document. Specific examples are the National Council for Prescription Drug Programs (NCPDP) data to CCD, CCD to the Continuity of Care Record (CCR), and the encapsulation of X12 and NCPDP and HL72.X in SOAP message. This type of flexibility can easily be used in custom instances or new circumstances as they arise.

IHE Profile Support (PIX Manager, XDS Registry, XDSRepository - The use of the IHE PIX, PDQ, XDS and XDR interfaces and mechanisms are described throughout this section of the document. They are an intrinsic part of the Arkansas Protocol Bus.

Role Based Access and Management - Role based Access and management spans several areas that have been described so far, specifically the Administration Portal (*Web Services Endpoints and Messaging)*, the Consent Registry and the Policy Engine. These areas combine to form a strong, tested system to ensure privacy and security of clinically sensitive data. Transactions requiring NHIN based SAML assertion data help to ensure this data is applied to the appropriate users in a trust model.

Terminology Management (HITSP C83 / C80 Support) - The Arkansas Protocol Bus implements a Terminology Normalization Service based on the Apelon Terminology Server. This service can be used in several ways, including document (e.g. CCD to C32) normalization on the fly, normalization of Clinical Data within a Relational Database Management System (RDBMS), or allowing service calls for specific field (system/value) translations. Of course, such terminology conversion does not work in a vacuum, and many times user intervention for correct mapping may be involved.

It is our feeling that an intermediate system can only do so much in this area and that strong governance of data source is the true means to semantic interoperability. But by providing some services to assist in the process, the Arkansas Protocol Bus can help smooth the way for the panacea of the pure C32.

Message and Data Validation - There is no specific data validation functionality currently within the GSI HIE. Message validation is, of course, provided by the XML parsers involved ion SOAP message marshalling throughout the system. There are several logic points for data validation where the functionality can be incorporated given detailed requirements.

System Administration - The Arkansas Protocol Bus implements an extremely functional Administration Portal. This portal allows for the configuration and certification of users, organizations, services, and service consumers. This includes security certificate exchange, security settings, role-based user authorization attributes, training and testing status.

Several different levels of administrators are allowed including bus administrator and several levels of organization administrators. Authorized users are tied into our "Provider Registry" for identification cross referencing across multiple organizations. Data on user document exchange endpoints and email addresses for Clinical Information Exchanges is also maintained in this system.

The administration portal is implemented within the application server and uses the Google Web Toolkit framework. The framework is AJAX based and extremely flexible, allowing for data entry and viewing.

System Configuration - The extent of configurability in a system this complicated is beyond the scope of this document. The Patient and User Registry functionality alone would exceed the limits of this section. There are 8 databases across the system that can have their connection pools configured in different ways among the hundreds of parameters that can be adjusted in an application server. That being said, the "out of the box" production deployment of the system should be configured correctly for the initial and mid-term needs of the product, based on testing and scaling throughout the implementation lifecycle.

This out of the box configuration needs to be tested under anticipated production loads and data quality. The performance impact of a minor setting change in one configuration parameter can be enormous; for example, the max number of active sessions, or the thread counts. Thorough documentation of configurability will be provided as part of the deliverable.

Privacy - Through the use of the Consent Registry, the Policy Registry and Security as outlined in this document, clinically sensitive patient information is protected to the full extent of state policy and Federal law. Please see these sections for further elaboration

Security - Access to view clinically sensitive data accessibility is governed by roles and their specific security parameters. This is the realm of the Policy Repository where the governments express policies are stored. This policy repository is in a secured database.

Authorization associates these roles and security parameters with each user. This is the realm of the Administration Portal, a secure system with its own user types to prevent inappropriate modification of user data.

Authentication of each user is either by user name and password controlled by database access or by trust with other systems and communication of authenticity across systems by SAML assertion. This SAML data is protected from tampering by digital signature and by encryption. Authentication of system nodes is provided by a bi-directional certificate security protocol which also provided data encryption and message element signing.

Auditing allows for the detection and traceability of violation of access rules. Audit logs are stored in a secure database where only authenticated administrators can access them.

Consent allows control of access via policy and patient preference. Patient preference is currently controlled by their representative user (e.g. PCP) but may eventually be placed in patients hands with their own level of Authentication (see Consent Registry and Policy Engine).

Logging - The Arkansas Protocol Bus includes a variety of instrumentation in the code for analysis and debugging purposes using any standard logging monitor. A specific logging library is used for the dynamic variation of logging levels to aid in real-time debugging.

All messaging that goes through the Arkansas Protocol Bus is logged in specific database tables whether the messaging is XDS/XDR or Subscribe/Notify. All user access usage and user initiated transactions are logged within database tables.

Finally there is an XDS.b audit database that specifically logs the IHE required auditable event data in a schema that directly reflects the audit messages in the IHE Technical Framework. This would also include al XDR transactions.

Monitoring - The Arkansas Protocol Bus will implement the Zenoss Enterprise IT service level management solution. Zenoss unifies and improves IT service monitoring of key application and business services across the datacenter. Zenoss has been around for several years and has left the legacy products behind. With this program a quick view of the dashboard tells how the application and servers are performing. It's also easily configured to shoot out an email or notification if something is amiss. In addition to Zenoss, we build instrumentation into the application logging that can be viewed through any logging monitor mechanism including Zenoss.

Reporting - As part of the Administration Portal, a series of reports on access, usage, policy adherence, transactions and transaction performance are made available to administrators with the proper role. This data is provided from several different schemas within the system.

Clinical Information Exchange

Technical architectural and approach

The Arkansas Protocol Bus implements an IHE XDS.b and XDR based standard interface for accepting and routing Clinical Data Summaries from and to other systems via SOAP based Web Services. The Clinical Information exchange mechanism has two different models, the "push model" and the "pull model."

Pull Model

The pull model is initiated with an XDS.b Document Register or an XDS.b Document Provide and Register. Enough patient demographic data must be present in the document registry metadata to allow for a PIX, or a separate PIX upload transaction must be made prior to the document registration.

Once the document is registered, it can be obtained by other providers using a combination of PIX or PDQs, XDS.b Document Query and Document Retrieve transactions. However such retrieval may require the full implementation of a patient consent mechanism, including SAML assertions.

Push Model

The push model begins with an XDR based Provide and Register Document, which is the same as the XDS.b version with an added "intended recipient" slot. If this slot is present, the document is forwarded to the intended recipient,

If the intended recipient has registered an IHE XDR endpoint (see Provider Registry), the XDR transaction is basically relayed to that endpoint by the Arkansas Protocol Bus. This endpoint registration is a function of the Arkansas Protocol Bus administration portal and the provider registry described later. If the intended recipient does not have a registered XDR Endpoint, an email based approach will be used to relay the document. A method to handle the relaying of data to specific PHRs should be based on NHIN Direct recommendations or IHE XDR.

NHIN Direct

This push model may be supplanted based on decisions made by the NHIN Direct committee. At this time, we feel NHIN Direct will implement XDR for IHE based systems and will further describe the email based system we propose for those who cannot implement and IHE system. NHIN direct may also come up with a REST based solution to the push model, which we will be ready to incorporate.

Standards Supported

Currently, the document types supported in the Arkansas Protocol Bus are Clinical Document Architecture (CDA) based and of the CCD type, though CCR will be totally acceptable. Documents are stored in their raw form so theoretically many types of documents can be stored in the repository or relayed. There is currently a process to parse CCD based documents into a clinical data repository for de-duplication, aggregation and terminology normalization. If desired, an operation to translate CCD to CCR and vice versa can be incorporated.

Terminologies

The CCD is quite flexible in the terminologies that can be used in many modules, much like HL7 2.X. As far as raw documents are concerned, XDS.b has no problems with any of these and is strictly WYSIWYG. Implementation of a more constrained HITSP C32 v2.5 is a matter of

policy more than technology. In order to help facilitate the standardization of terminology per the HITSP C80/C83 standards, we are providing a terminology service which can be used for data normalization.

NHIN Compatibility

The IHE XDS.b mechanism is generally accepted as the defacto standard for document transfer using the pull mechanism and is part of the NHIN-Gateway. It is expected that the IHE XDR standard will gain favor for the pull mechanism with the backing of NHIN Direct. Other interfaces (e.g. REST, SNMP) proposed by NHIN Direct will be implemented within this framework as need be.

9.3 Value-Added Services

Population-based Health Management and Reporting

The Arkansas Protocol Bus implements an IHE Publish/Subscribe based standard interface for what is known as the UPHN. Within the UPHN subscription is a Web Service notification endpoint to which the subscription response data is delivered. The subscription payload is a flexible public health querying mechanism based on the CDC minimal data set (MDS) for Biosurveillance. Based on the query type and criteria, a variety of data formats and content can be delivered from the node to the subscribing system in the notification.

The interface between the Arkansas Protocol Bus UPHN and the source data systems (HIS, EHRs) is normally an HL7 2.5 secure socket interface, as is used in most hospital systems. HL7 2.5 data is relayed to the UPHN on a streaming basis, and aggregated in a special Clinical Data Repository (CDR). The UPHN queries this repository on a periodic or as needed basis, depending on the query criteria in the subscription. Notification containing the queried data is provided back to the notification endpoint.

The CDR is basically an online analytic processing (OLAP) star model which lends itself easily to a Decision Support Systems (DSS) system such as the Business Objects system described "*Web Viewers for Providers Without EHRs."* This allows for detailed reporting as well as the standard payloads.

Standards Supported

The subscription payload is a non-standard set of query criteria modeled on the CDC MDS and standard query language parameters such as "and," "or," "in," "like," "not," "=," etc. No NHIN facility for such detailed querying was found.

The notification returns a variety of payloads. These include HL7 2.5, CCD and CDA HAVE. The payload type is based on subscription criteria settings. Because of the flexibility of the Publish/Subscribe interface, different payload types can be easily substituted.

Terminologies

HL72.5 and CCD may allow for multiple terminologies based on type descriptors. Terminologies can be standardized or translated within the Arkansas Protocol Bus as need be using the Terminology Normalization Service.

NHIN Compatibility

The IHE Publish/Subscribe mechanism is the basis for the NHIN Health Information Event Messaging. It is used as the NHIN Biosurveillance protocol.

Quality Reporting

The Arkansas Protocol Bus implements an XDS.b Based Provide and Register Document transaction for QRDA type III based documents. This allows HIS and EHR systems to upload their quality measure data to the Arkansas Protocol Bus. The document is then parsed into a RDBMS where data can be aggregated and analyzed within a Quality Reports Portal using the DSS Business Objects. Data can also be forwarded to government authorities from this database. There is also scheduled implementation of a Publish/Subscribe interface for the dissemination of Health Quality Measures Format (HQMF) Measure Descriptions to subscribing organizations.

Policy Engine

The Arkansas Protocol Bus implements a XACML based policy engine for governing patient based consent. Policy statements dictated by a patient or by the state are encoded in XACML and are persisted in the system. These statements are executed upon receipt of a XACML based request containing user authentication data, usually supplied by a SAML assertion. The policy engine supplies an XACML response (permit, deny) to the request. Policies can be adjusted dynamically without code changes and can be extremely detailed per the XACML policy specification.

Laboratory Ordering and Results Delivery

Technical architectural and approach

The Arkansas Protocol Bus implements an IHE Publish/Subscribe based standard interface for accepting Lab Orders from ordering systems via SOAP based Web Services. Within the Lab Order subscription is a Web Service notification endpoint to which lab result data is delivered. The subscription payload is an HL72.X order as it is provided now, in raw form.

The interface from the Arkansas Protocol Bus to the specific labs is on a case by case basis. Proprietary interfaces could be continued as they are now. Interfaces using the standardized protocols would be easier to implement from the bus point of view and have more flexible configurability within the system.

Currently Lab results are passed back asynchronously from the labs to the Arkansas Protocol Bus using a mechanism that is case by case as well. Results are relayed back to the ordering system using the provided notification endpoint. This asynchronous notification mechanism allows for the time necessary to the testing workflow.

Standards Supported

Currently the subscription and notification both use HL7 2.x based payloads. Because of the flexibility of the Publish/Subscribe interface, different payload types can be easily substituted. Currently implementation is being negotiated with LabCorp.

Terminologies

HL72.x allows for multiple terminologies based on a type descriptor for ordering, test types and results. Terminologies can be standardized or translated within the Arkansas Protocol Bus as need be through the use the Terminology Normalization Service.

NHIN Compatibility

The IHE Publish/Subscribe mechanism is the basis for the NHIN Health Information Event Messaging. It is used as the NHIN Biosurveillance protocol in NHIN Connect.

Electronic Prescribing (e-Prescribing)

Technical architectural and approach

The Arkansas Protocol Bus implements an IHE Publish/Subscribe based standard interface for accepting e-prescriptions from prescribing systems via SOAP based Web Services. Within the e-Prescribing subscription is a Web Service notification endpoint to which subscription response data is delivered. The subscription payload is an NCPDP based message as it is provided now, in raw form.

The interface from the Arkansas Protocol Bus to the specific pharmaceutical service provider is on a case by case basis. Proprietary interfaces could be continued as they are now. Interfaces using the standardized protocols would be easier to implement from the bus point of view and have more flexible configurability within the system.

Currently subscription responses are passed back from the pharmaceutical service providers to the Arkansas Protocol Bus using a mechanism synchronous with the request. Results are relayed back to the ordering system using the provided notification endpoint. This asynchronous notification mechanism allows for non-blocking operations in the requesting system in case the service provider has long lag times in their legacy system.

Standards Supported

Currently, the subscription and notification both use NCPDP based payloads. NCPDP version 10.5 is preferable because of its XML format. Because of the flexibility of the Publish/Subscribe

interface, different payload types can be easily substituted. Currently implementation is being tested with SureScripts.

Terminologies

NCPDP may allow for multiple terminologies based on type descriptors for pharmaceuticals. Terminologies can be standardized or translated within the Arkansas Protocol Bus as need be using the Terminology Normalization Service.

NHIN Compatibility

The IHE Publish/Subscribe mechanism is the basis for the NHIN Health Information Event Messaging. It is used as the NHIN Biosurveillance protocol.

Medication History

Technical architectural and approach

The Arkansas Protocol Bus implements an IHE Publish/Subscribe based standard interface for accepting Medication History requests from other systems via SOAP based Web Services. Within the MedHistory subscription is a Web Service notification endpoint to which subscription response data is delivered. The subscription payload is an NCPDP based message as it is provided now, in raw form. The requesting system may be a PHR, an EHR or an HIS.

The interface from the Arkansas Protocol Bus to the specific pharmaceutical data provider is on a case by case basis. Proprietary interfaces could be continued as they are now. However, interfaces using the standardized protocols would be easier to implement from the bus point of view and have more flexible configurability within the system. The pharmaceutical data provider may be a government agency, an HIO or a government agency. Data can be "scatter gathered" to multiple systems from one subscription.

Currently Medication History responses are passed back from the pharmaceutical data provider to the Arkansas Protocol Bus using a mechanism synchronous with the request. Results are relayed back to the requesting system using the provided notification endpoint asynchronously. This asynchronous aspect is important to allow for several capabilities including terminology normalization and aggregation. The asynchronous notification mechanism allows for non-blocking operations in the requesting system in case any service providers have long lag times in their legacy system.

Standards Supported

Currently the med history subscription request uses an NCPDP based payloads. NCPDP version 10.5 is preferable because of its XML format. The notification payload can be either an NCPDP payload or translated to a simple medication history based CCD or a CCR if need be. Because of the flexibility of the Publish/Subscribe interface, different payload types can be easily substituted. Currently implementation is being tested with NY State Medicaid.

Terminologies

NCPDP may allow for multiple terminologies based on type descriptors for pharmaceuticals Terminologies can be standardized or translated within the Arkansas Protocol Bus as need be using the Terminology Normalization Service.

NHIN Compatibility

The IHE Publish/Subscribe mechanism is the basis for the NHIN Health Information Event Messaging. It is used as the NHIN Biosurveillance protocol.

Eligibility and Authorization Unification

Technical Architectural and Approach

The Arkansas Protocol Bus will implement an IHE Publish/Subscribe based standard interface for accepting Eligibility and Authorization requests from external systems via SOAP based Web Services. Within the E-Prescribing subscription is a Web Service notification endpoint to which subscription response data is delivered. The subscription payload would be an X12/270 based message as it is provided now, in raw form.

The interface from the Arkansas Protocol Bus to the specific payor service provider is on a case by case basis. A routing mechanism based on patient/payer information will need some detailed requirements. Proprietary payer interfaces could be continued as they are now. Interfaces using the standardized protocols would be easier to implement from the bus point of view and have more flexible configurability within the system.

Subscription responses are most likely passed back from the payer service provider to the Arkansas Protocol Bus using a mechanism synchronous with the request. Results are relayed back to the requesting system using the provided notification endpoint. This asynchronous notification mechanism allows for non-blocking operations in the requesting system in case the service provider has long lag times in their legacy system. It also allows for the forwarding of the billing response to other systems with appropriate endpoints.

Standards Supported

The subscription and notification would both use X12-270/271 based payloads. Because of the flexibility of the Publish/Subscribe interface, different payload types can be easily substituted.

Terminologies

X12 may allow for multiple terminologies based on type descriptors. Terminologies can be standardized or translated within the Arkansas Protocol Bus as need be using the Terminology Normalization Service.

NHIN Compatibility

The IHE Publish/Subscribe mechanism is the basis for the NHIN Health Information Event Messaging. It is used as the NHIN Biosurveillance protocol.

Web Viewers for Providers Without EHRs

Technical architectural and approach

The Arkansas Protocol Bus implements a series of portals, including a Community View Portal for registered users to carry out specific functions without an EHR being involved. Specifically, the viewing of CCD based documents is currently in implementation. This portal would serve as a framework for any other additional functionality to be implemented, including data entry.

The community portal is implemented within the application server and uses the Google Web Toolkit framework. The framework is AJAX based and extremely flexible, allowing for data entry and viewing. This includes lab order entry, lab result viewing, and patient document querying.

For more complicated decision support type viewing and reporting, Business Objects is leveraged within the various portals. Business Objects is a standard DSS that allows for complicated pivot, drill down and multidimensional "slice and dice" operations on data stored in relational database. This includes the system Clinical Data Repository (populated by CCD's) and the Quality Measures Database. A quality measure reporting portal is currently under development using Business Objects.

Radiological Image Exchange - The XDS.b Document exchange system is fully capable of handling images as documents. Metadata for such images are stored in the document registry specifically for documents that do not self contain metadata (patient id, author, dates, etc.)

An Image viewer can be incorporated into the Community Viewer Portal for providers who need such a mechanism. This portal's approach is described in "*Web Viewers for Providers Without EHRs.*"

End User Integration Experience - Currently, the GSI HIE has conducted end user integration testing with EHR vendors and State Agency data consumers including the deployment of our privacy and security services, Core Services, and functional services for Clinical Summary Exchange and Public Health Reporting.

Appendix A: Glossary of Acronyms

AMA	American Medical Association
AR	Arkansas
ARRA	American Recovery and Reinvestment Act of 2009
CCD	Continuity of Care Document
CCR	Continuity of Care Record
CDA	Clinical Document Architecture
CDR	Clinical Data Repository
CSE	Clinical Summary Exchange
DSS	Decision Support Systems
DTS	Distributed Terminology System
EHR	Electronic Health Record
EMR	Electronic Medical Record
ESB	Enterprise Service Bus
EUID	Enterprise User Identification
HIE	Health Information Exchange
HIO	Health Information Organization
HIS	Hospital Information System
HIT	Health Information Technology
HITSP	Healthcare Information Technology Standards Panel
HL7	Health Level 7
HQMF	Health Quality Measures Format
MDM	Master Data Management
MDS	Minimal Data Set
MPI	Master Patient Index
NCPDP	National Council for Prescription Drug Programs
NHIN	Nationwide Health Information Network
NYSDOH	New York State Department of Health
OLAP	Online Analytic Processing
PDQ	Patient Demographic Query
PIX	Patient Identity Cross Reference
PHR	Personal Health Record

QA	Quality Assurance
QRDA	Quality Reporting Document Architecture
RDBMS	Relational Database Management System
RFI	Request for Information
RFP	Request for Proposals
RHIO	Regional Health Information Organization
SHARE	Arkansas State Health Alliance for Records Exchange
SHIN-NY	Statewide Health Information Network for New York
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SQL	Structured Query Language
THINC	Taconic Health Information Network and Community
UDDI	Universal Description, Discovery and Integration
UIX	User Identity Cross Reference
UPHN	Universal Public Health Network
WIST	Web Services Interoperability Technology
XDR	External Data Representation